DOCUMENT RESUME

ED 082 274 EA 005 142

AUTHOR	Baas, Alan M.
TITLE	Construction Management. Educational Facilities Review Series Number 20.
INSTITUTION	Oregon Univ., Eugene. ERIC Clearinghouse on Educational Management.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	Sep 73
CONTRACT	OEC-0-8-080353-3514
NOTE	8p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Architectural Programing; Construction Costs; *Construction Management; *Educational Facilities; Fast Track Scheduling; *Literature Reviews; Modular Building Design; School Construction; Systems Approach
IDENTIFIERS	Building Systems

ABSTRACT

Replacing the general contractor with a "construction manager" directly accountable to the owner promises greatly improved control over cost and scheduling economies. The construction manager should have special skills in construction, cost analysis, critical path method scheduling, and be familiar with the qualifications of local subcontractors. When coordinated with fast-track scheduling (overlapping phases of design and construction that have traditionally occurred end-to-end) and pre-engineered building systems, construction management not only achieves dramatic savings in time and money, but also insures that the completed building meets the objectives for which it was originally intended. This review surveys many recent journals and several documents previously announced in ERIC catalogs pertaining to the conception and application of construction management for school building programs. The majority of the literature surveyed discusses the nature of the construction management team, emphasizing the need for the educator-client to participate directly in the decisionmaking processes of the building program. (Author)

EDUCATIONAL RESOURCES INFORMATION CENTER • CLEARINGHOUSE ON EDUCATIONAL MANAGEMENT

EDUCATIONAL FACILITIES REVIEW SERIES

—an ongoing survey of topics in educational management designed to provide the practicing educator with reviews that are contemporary and sensitive to education's changing information requirements. Most of the reports cited in the reviews have been processed by this and other clearinghouses in the ERIC system and announced in *Research in Education (RIE)*, ERIC's monthly index and abstract catalog.

EA 005 142

ED 082274

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

September 1973 Number 20

Construction Management

Alan M. Baas

Today's educational programs and community needs are changing so rapidly that a school facility requiring three or four years to build might well be obsolete before its doors open. With construction costs escalating at the rate of 1 percent per month it is obvious why school boards are seeking new ways of streamlining their school building programs. Construction management, when properly understood by the educator-client, offers significant savings in both time and money. It can also ensure that the completed facility meets the educational functions for which it was designed.

Essentially, the concept rationalizes the administrative techniques necessary for management of all phases of a building project and provides for pecific contractual procedures geared to increased owner control over costs and scheduling. With the help of a skilled construction manager (usually a firm of specialists), the owner can establish direct contractual relations with all subcontractors. More realistic control is maintained over the building program than is possible under traditional owner-general contractor arrangements. The architect retains most of his traditional functions and, like the construction manager, is directly responsible to the owner.

The construction manager is responsible for organizing bidding procedures, performing regular cost and scheduling analyses, and interfacing all phases of the building program. By predicting potential costs and construction delays, he can

help the owner make design decisions early enough to avoid last-minute changes that compromise the program's objectives.

The majority of the literature surveyed in this review discusses the nature of the construction management team, emphasizing the need for the educator-client to participate directly in the decision-making processes of the building program.

While *fast-track scheduling* and *building systems* are not part of the basic concept of construction management, most writers agree that the three concepts increase in value as they are properly coordinated in a single approach. Construction management rationalizes the management of the building project; fast-tracking and building systems are among the time- and money-saving tools that may be coordinated under the construction management concept.

Fast-tracking overlaps activities in the design and construction processes that have traditionally occurred end-to-end. Thus, site preparation and excavation can begin while the designs for the schoolhouse are still on the drawing boards. Foundations may similarly be laid and the "shell" (building structure) erected before final decisions have been made concerning allocation and design of interior spaces. Use of preengineered building systems (structural, thermal, ceiling, partitions) designed on a "modular" scale permits decisions on interior arrangements to be made after the building shell has been constructed. This reduces on-site construction time and enhances the building's capacity for changing in response to future needs.

CONSTRUCTION MANAGEMENT

Cautioning that the owner must select the combination of management strategies best suited to the needs of his particular building project, Stanley (1973) describes and compares four basic types of building project delivery systems: inhouse, conventional, design-construct, and construction management.

If the owner's organization is large enough, *inhouse* staff may be used to handle project management conception, design, and, on occasion, construction. This eliminates any external conflicts of interest, lends itself to accelerated fast-track scheduling, and offers substantial control over all phases of the project.

Under *conventional* building project arrangements, the owner retains an architect-engineer firm or firms to develop a design and to award construction contracts. The risk of design "surprises" is minimized because the design is completed before construction contracts are awarded. This approach also works well with the legal requirements for public works in many states. It does not, however, lend itself to fast-track scheduling, thus necessitating longer schedules and possibly higher costs due to inflation.

Also known as turnkeying or design-build, *design-construct* enables the owner to contract with a single company for the design and construction of the project. The concept is simple and appealing to owners, but it also raises conflict of interest questions. Savings in both time and money can be gained when this approach is used in conjunction with fast-track scheduling and systems building techniques.

The fundamental advantage of *construction management* is that it allows the owner direct control over the building project and eliminates conflict of interest problems. The approach is very flexible and permits

the construction management firm to tailor its services to supplement those already available within the owner's organization. It is easily adaptable to fast-track scheduling and systems building techniques. It also offers effective cost and quality controls and facilitates maximum interaction with the owner throughout the process.

In a recent interview for *American School & University* ("What Construction Management Can Do for You" 1973), Charles Thomsen, the president of a firm specializing in construction management, summarizes the benefits of this approach:

> By increasing control of the building process, construction management makes it more predictable and, therefore, faster and more economical. The construction manager is a professional, performing the management and coordination roles of a general contractor, but instead of selling a product—the building—he's a manager purchasing the construction for the owner.

Thomsen points out that, unlike the general contractor who is chosen because he is low bidder, the construction manager is a professional chosen on the basis of his proven abilities to perform. The typical construction management firm consists of a number of skilled specialists drawn from throughout the building industry, including architecture, general contracting, systems engineering, and management science. Combining construction and management science skills in one coordinated team permits accurate definition of cost and scheduling alternatives, extensive owner participation in building project decision-making, and, if need be, efficient use of fast-track scheduling and systems building techniques.

Thomsen illustrates the range and variety of possible construction management services by citing the experiences of his own company in constructing a $3.5 million high school with dramatic savings in both time and money for the school district.

The traditional arrangement of client, architect, and general contractor cannot, according to Tropf (1972), provide adequate accountability to the educator-client. He recommends instead a team approach that replaces the general contractor with a "construction manager" and enables the owner to retain more control over the construction process.

> The team concept simply places disciplines on cost, duration and quality and gives to the owner direct control and accountability of these disciplines. Expediting construction under the team concept of construction manager has resulted in cost savings of twenty to forty percent when compared with conventional methods. And, most importantly, cost and duration became known controllable factors early in the project.

Serving as an agent of the owner in dealing directly with trade contractors, the construction manager can help eliminate much of the speculation associated with conventional bidding practices. He must be knowledgeable about the practicality of different construction methods and familiar with the limitations and abilities of local subcontractors. He should also be independent of the architect and may be paid by the hour, at a lump sum fee, or at an hourly rate with a "not-to-exceed" figure.

A good construction manager is expert at cost-estimating and skilled in construction work allocation, scheduling, and supervision. By performing value engineering on each design conecpt, construction method, and building component, he can give the owner reasonably accurate estimates of project costs. He is also responsible for purchasing and performance schedules and expedites all communication with the bidders.

For effective involvement in the management team, the owner must have a direct contractual relationship with each firm providing materials or services. Pointing out that design has an inherent conflict with cost and duration, Tropf advises the owner to establish a check and balance system under his direct control. He also recommends fees based on services and materials rather than on a percentage of costs. Preliminary plans should be completed prior to asking voter approval to build. Planning funds may be obtained by asking the voters' approval or, in some cases, from special state planning grants.

Perkins (1971) agrees that construction management techniques can eliminate costly scheduling delays and increase owner control of construction options. By predicting potential complications and budget excesses in advance, a well-organized construction management team can make decisions early enough to prevent troublesome compromises between the building's design and program objectives.

If school boards and administrators are to accept the new responsibilities necessary for effective construction management, they must understand four basic concepts:

- As key member of the project development team, the client must be ready to deal effectively with team organization, identification of project needs, and final decision-making.
- Members of the team should be able to handle all problems relating to the building program, particularly those pertaining to project costs and construction technicalities.
- The team should enter the project early enough to control programming and conceptual design decisions and ensure maximum utilization of all its options, including control of future costs and time expenditures.
- If programming, design, and construction schedules are overlapped in a single "phased" (fast-track) process, construction may begin before the design stages are completed, thereby significantly reducing overall project time.

NEW DEFINITION

Construction management is defined as 'a management alternative to provide construction expertise from the very early stages in order to have construction concept and cost control concurrent with the development of the design concept.' A construction management firm is responsible for cost estimates and budget control, review of design during the entire process, construction scheduling, pre-purchasing of critical materials and equipment for the owner where necessary, advising on the method of obtaining contractors, recommending the award of contract(s) on the basis of competitive bidding, and coordination and direction of all construction activities.

quoted in *Perkins (1971)*

With early planning, legal restrictions pertaining to phased construction can be confronted and resolved without interrupting project momentum. Similarly, by identifying the numerous components required for building, the construction manager can analyze cost and availability options in advance and effectively coordinate the many contracts required by phased scheduling.

Perkins concludes with a brief summary of questions owners may ask in evaluating prospective construction management firms. A competent firm should give adequate information about its background and relation to the field, the types of consultants and services it provides, and what legal responsibilities it will assume.

Ideas for making the construction process shorter, smoother, and more economical appear in a speech by MacMahon (1971). After reviewing the major problems in public construction, he recommends development of a construction manager position to be filled by a person who is skilled in all aspects of construction and who would represent the owner's interests.

According to MacMahon, poor construction management is the major cause of project time-problems. Critical areas where a construction manager might contribute to a more efficient building program are outlined and discussed.

Architects can provide construction management services, Meathe (1973) reports, provided they fully understand its principles. The approach involves four simple actions:

- identifying the problems and the problem areas
- reviewing various options to which these problems might respond
- making decisions based on this evidence
- implementing those decisions as quickly as possible after they are made

Architects wishing to enter this field must possess skills in cost-estimating, critical path method scheduling, financial planning, and client relations. Meathe's description of these skills stresses the value of cooperative team planning and use of fast-track scheduling techniques.

Proper management of scheduling and construction can avoid the effect of cost escalation over long periods of building without sacrificing quality of design, materials, or equipment. Savings also result from dividing contracts into the optimum number of bid packages to provide for adequate competition and realistic prices. If those contracts are bid as close to actual installation as possible, the contractor does not have to speculate against inflated costs.

Cautioning that there are few precedents for defining the legal aspects of construction management, Collins (1972) briefly describes seven areas of potential liability: substantial performance, interpretation of time, impossibility of performance, third-party impairments, reliance on promises, notice/participation in condition of planning and construction, and damages. He suggests that educators may avoid costly court cases by drafting legal contracts according to methods of reasoning and analysis outlined in his discussion.

Construction Management Tools

Speeches by university administrators (Lamison and others 1972) detail the use of new management techniques and fast-track scheduling for the construction of three separate student housing facilities. In addition to itemizing recommended procedures for all aspects of the program, the speeches identify potential pitfalls and point out possible disadvantages of fast-tracking. Because such a high premium is placed on the forward momentum of the project, input from all interested members of the educational community is limited once fast-tracking is in motion. Effective fast-tracking also depends on rapid circulation of information to all parties, thus placing a burden on the educator-client to have a representative at all meetings.

Coordinating construction management with fast-track scheduling and systems building techniques offers speed of response, flexibility, economy, and more opportunity for the educator-client to participate in the design process. King (1972) describes the characteristics of each of these concepts and cites examples of how their combined

use results in improved educational facilities.

"Systems building" rationalizes the decision-making process in building design and construction and may, though not necessarily, employ "building systems" of preengineered components to achieve benefits in economy, quality, and speed. Building systems are factory-constructed according to "modular" dimensions that permit their rearrangement in response to various design requirements. They work well with the overlapping schedules of fast-tracking because their modular design requires minimal on-site effort. In addition, their flexibility means that the interior designs for a building need not be completed before initial construction begins.

King points out that use of a construction manager takes the management role of contracting out of the realm of profit-based business and places it under the direct control of the client. He also gives a brief description of the skills necessary for a construction manager to integrate the advantages of fast-tracking and building systems.

The successful use of construction management and a modified systems approach to coordinate building four additions to Detroit public schools is evaluated in a recent *CEFP Journal* article by Featherstone (1972). Average cost savings amounted to $6.60 per square foot, and completion time was an estimated 60 percent of that expended by comparable programs using conventional methods.

Featherstone's analysis emphasizes the value of performance specifications, phased bidding, and fast-track scheduling. He also stresses the need for intensive owner involvement and close cooperation among all participants of the project. Many of his findings reinforce conclusions presented by other articles surveyed in this review. Some additional observations are worth noting.

- Not all building programs lend themselves to acceleration, nor do their needs demand the concentrated effort required.
- Most schools built in the same region have certain common elements (components) which lend themselves to repetition without the limitations of design standardization.
- The ability of school board owners to respond quickly to community needs for school facilities may have societal benefits as well as economic advantages.
- Phased bidding increases the owner's hold on costs but adds somewhat to risk, increasing need for owner competence and administrative flexibility.
- Through the experience and confidence gained by the participants, the cost/time efficiency factors can be expected to improve markedly in a subsequent program which utilizes some or all of the original building team members.

Excellent client cooperation and coordination of building systems with fast-track scheduling by a construction manager enabled completion of two vocational schools in nine months ("Bell and Howell Schools" 1972). Client willingness to defer decisions until the appropriate stage of the project was instrumental in keeping design options open and ensuring that the buildings were not functionally obsolete the day they opened. As a result of the use of modular building systems, the completed facilities are flexible enough to ensure client options remaining open for the forty-year lifetime of the buildings.

Use of preengineered building systems greatly facilitated the tight design/construct schedule of the two schools. The construction manager's knowledge of current construction-industry conditions provided for numerous cost-cutting decisions.

Effective fast-tracking also entailed the manager's close supervision of every phase of the project, thereby preventing costly time lags caused by late deliveries of materials or other schedule breakdowns.

While building systems, fast-tracking, and construction management each has its own kinds of risks, the successful coordination of the three concepts by a qualified construction manager can provide attractive and cost-effective facilities with a high degree of flexibility.

REFERENCES

Documents cited with ED numbers are abstracted in *Research in Education*. The complete texts are available from the ERIC Document Reproduction Service (EDRS), commercial channels, or both. Publications can be ordered in either Xerox copy form (HC) or microfiche (MF).

For each order, indicate the ED numbers of the desired publications, the type of reproduction desired (paper or microfiche), and the number of copies being ordered.

Payment must accompany orders under $10.00. Postage, at book rate or library rate, is included in the price of the document. If first class mailing is desired or if shipment is outside the continental United States, the difference between book rate or library rate and first class or foreign postage will be billed at cost. All orders must be in writing.

Journal articles cited with EJ numbers are indexed in *Current Index to Journals in Education*, a monthly companion index to *Research in Education*. Reproductions of the journal articles are not available from EDRS.

Address requests to ERIC Document Reproduction Service, P.O. Drawer O, Bethesda, Maryland 20014.

Baas, Alan M. *Systems Building Techniques. Analysis and Bibliography Series, No. 15.* Eugene: ERIC Clearinghouse on Educational Management, University of Oregon, 1972. 21 pages. ED 065 897 MF $0.65 HC $3.29.

"Bell and Howell Schools: Orchestrated Innovation." *Planning for Higher Education*, 1, 2/5 (October 1972), pp. 5-8.

Collins, George J. "Construction Management: Legal Implications." *CEFP Journal*, 10, 5 (September-October 1972), pp. 8-11. EJ 068 175.

Featherstone, Richard L. "Analyzing Detroit's Initial Systems Project." *CEFP Journal*, 10, 6 (November-December 1972), pp. 8-11. EJ 067 463.

King, Jonathan. "New Ways to Build—Or, How to Get Your School Built before You Retire." *National Elementary Principal*, 52, 1 (September 1972), pp. 17-22. EJ 064 170.

Lamison, Robert M., and others. *Housing in a Hurry. Proceedings of North Atlantic Conference. (Cambridge, Massachusetts, March 18, 1972.)* Cambridge, Massachusetts: Society for College and University Planning, 1972. 63 pages. ED 069 038 MF $0.65 HC $3.29.

MacMahon, Charles H., Jr. "Management of Time, Cost and Quality in Public Construction Today. (An Idea Whose Time Has Come.)" Paper presented at Council of Educational Facility Planners Great Lakes Regional Conference, East Lansing, Michigan, March 1971. 14 pages. ED 049 544 MF $0.65 HC $3.29.

Meathe, Philip J. "It's a Wide Open Field: Construction Management." *AIA Journal*, 59, 3 (March 1973), pp. 41-43.

Perkins, Bradford. "A New Building Program Can Run Smoothly." *School Management*, 15, 9 (September 1971), pp. 35-37. EJ 043 506.

Stanley, Richard H. "Project Management and Construction: An Approach to Meeting Owner Needs." *Consulting Engineer*, 41, 2 (August 1973), pp. 103-110.

Tropf, Carl F. "Construction Management: The Team Concept." *CEFP Journal*, 10, 5 (September-October 1972), pp. 4-7. EJ 068 123.

"Vocational Schools Are Fraternal Twins." *Progressive Architecture*, 53, 2 (February 1972), pp. 74-79. EJ 051 402.

"What Construction Management Can Do for You." *American School & University*, 45, 9 (May 1973), pp. 12-23.

SUPPLEMENTARY BIBLIOGRAPHY

Brickert, John T. "Fast Tracking Saves UNF Time, Money." *Consulting Engineer*, 38, 5 (May 1972), pp. 106-111. EJ 058 944.

"The Changing Role of the General Contractor. A Building Design and Construction Special Study." *Building Design and Construction*, 12, 4 (April 1971), pp. 43-50. EJ 036 479.

ERIC Clearinghouse on Educational Facilities. *Analysis and Programing Educational Facilities. A Selected Bibliography*. Madison: University of Wisconsin, 1970. 21 pages. ED 041 378 MF $0.65 HC $3.29.

Fremouw, Gerrit D. "HEW: A/Es Need New Techniques. Federal Construction." *Consulting Engineer*, 38, 3 (March 1972), pp. 113-118. EJ 053 963.

Gruzen, Jordon, and others. "How to Help–and Hinder–Your Architect." *American School & University*, 43, 7 (March 1971), pp. 18-20, 22. EJ 036 477.

To gather the documents in this review, *Research in Education* and *Current Index to Journals in Education* were searched from January 1968 through March 1973, using as search terms these descriptors: **Architectural Programing** and **Construction Management.**

McGuffey, C. W. "Accountability in Planning Facilities." *CEFP Journal*, 10, 2 (March-April 1972), pp. 4-6. EJ 055 912.

Taylor, Robert. "What Management Contract Systems Mean to a Board." *School Progress*, 39, 12 (December 1970), pp. 22-23. EJ 029 833.

"Technology: Multiple Contracting, Fastrack Scheduling, and Quick-Step Drawings." *Architectural Forum*, 134, 5 (June 1971), pp. 56-59. EJ 040 753.

Tonigan, Richard. "What Are the Latest Project Management Techniques?" *School Management*, 16, 7 (July 1972), pp. 6-7. EJ 061 345.

Clearinghouse Accession Number: EA 005 142

Prior to publication, the manuscript was submitted to the Council of Educational Facility Planners for critical review and determination of professional competence. This publication has met such standards. Points of view or opinions, however, do not necessarily represent the official view or opinions of the Council of Educational Facility Planners.

The Educational Resources Information Center (ERIC) is a national information system operated by the National Institute of Education. ERIC serves educators by disseminating research results and other resource information that can be used in developing more effective educational programs.

The ERIC Clearinghouse on Educational Management, one of several such units in the system, was established at the University of Oregon in 1966. The Clearinghouse and its companion units process research reports and journal articles for announcement in ERIC's index and abstract bulletins.

Research reports are announced in *Research in Education (RIE)*, available in many libraries and by subscription for $38 a year from the United States Government Printing Office, Washington, D.C. 20402.

Journal articles are announced in *Current Index to Journals in Education. CIJE* is also available in many libraries and can be ordered for $44 a year from CCM Information Corporation, 866 Third Avenue, Room 1126, New York, New York 10022.

Besides processing documents and journal articles, the Clearinghouse prepares bibliographies, literature reviews, monographs, and other interpretive research studies on topics in its educational area.

The ERIC Clearinghouse on Educational Management operates under contract with the National Institute of Education of the United States Department of Health, Education, and Welfare. This review was prepared pursuant to that contract. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official Institute of Education position or policy.

ERIC Clearinghouse on Educational Management, University of Oregon, Eugene, Oregon 97403